FORM PTO-1390 (Modified) (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
203424US0XPCT	
U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	09/786059

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FR00/01891	03 JULY 2000	01 JULY 1999

TITLE OF INVENTION
METHOD FOR DEPOSITING A SILICON-CONTAINING DIELECTRIC MATERIAL ON COPPER

APPLICANT(S) FOR DO/EO/US
Pascale MOTTE, et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C 371 (c) (2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau)
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Request for Consideration of Documents Cited in International Search Report
Notice of Priority
PCT/IB/308
Drawings (1 sheet)

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/786059	PCT/FR00/01891	203424US0XPCT

21. The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1 445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO	$1,000.00
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO	$860.00
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	$710.00
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)	$690.00
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)	$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT = $860.00

Surcharge of **$130.00** for furnishing the oath or declaration later than ☒ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)). $130.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	18 - 20 =	0	x $18.00	$0.00
Independent claims	2 - 3 =	0	x $80.00	$0.00
Multiple Dependent Claims **(check if applicable)**.			☐	$0.00

TOTAL OF ABOVE CALCULATIONS = $990.00

Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable)**. ☐ $0.00

SUBTOTAL = $990.00

Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). + $0.00

TOTAL NATIONAL FEE = $990.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable)**. ☐ $0.00

TOTAL FEES ENCLOSED = $990.00

Amount to be: refunded	$
charged	$

☒ A check in the amount of **$990.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **15-0030** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

22850

Surinder Sachar
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Surinder Sachar
SIGNATURE

Norman F. Oblon
NAME

24,618
REGISTRATION NUMBER

March 1 2001
DATE

203424US0X PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :

PASCALE MOTTE ET AL : ATTN: APPLICATION DIVISION

SERIAL NO: NEW PCT APPLICATION :
(Based on PCT/FR00/01891)

FILED: HEREWITH :

FOR: METHOD FOR DEPOSITING A SILICON-CONTAINING DIELECTRIC MATERIAL ON COPPER

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to examination on the merits, please amend the above-identified application as follows.

IN THE CLAIMS

Please cancel Claims 1-18.

Please add the following claims:

--19. A method for depositing a dielectric material on copper apparent on the surface of a structure, entailing the following steps:

placing the structure in a deposit chamber of CVD type (Chemical Vapour Deposition),

adding to the chamber a first gas forming a precursor for the formation of the dielectric material and containing an element able to contaminate copper,

adding to the chamber a second gas containing a chemical element intended, together with the element contained in the first gas and able to contaminate copper, to form said dielectric material, the second gas being able to react with the first gas to give the deposit of dielectric material,

performing the deposit of dielectric material from the first gas and the second gas,

the method also comprising a step for adding a third gas able to prevent the contamination of copper by said element contained in the first gas.

20. The method according to claim 19, in which the deposit chamber permitting plasma assisted Chemical Vapour Deposition (PECVD), the method comprises a step for lighting the plasma to make the deposit of dielectric material from the first gas and the second gas.

21. The method according to claim 19, in which the first gas is silane, the contaminating element being Si.

22. The method according claim 19, in which said chemical element of the second gas is nitrogen.

23. The method according to claim 19, in which the 5 second gas is nitrogen.

24. The method according to claim 19, in which the third gas contains oxygen and/or nitrogen and/or carbon.

25. The method according to claim 24, in which the third gas is chosen from the group made up of N_xO_y, C_xH_y, a xN_2+yH_2 mixture or a xO_2+yN_2 mixture.

26. The method according to claim 24, in which the third gas is chosen from the group made up of NH_3, N_2O, CH_4 and C_2H_6.

27. The method according to claim 19, in which the first, second and third gases are also added before lighting of the plasma, the flow rates of the first, second and third gases,

the energy required for depositing and the time of formation of the deposit being adjusted in relation to the desired thickness of the dielectric material and its desired physical properties. '

28. The method according to claim 20, in which the steps are conducted in the following order:

placing the structure in the deposit chamber,

adding the third gas to the deposit chamber, the third gas being chosen to reduce the oxides present on the surface of the copper,

lighting a plasma of third gas in the deposit chamber in order to reduce said oxides, adding the first and second gases to the deposit chamber, adjustment of the flow rates of the first, second and third gases, of the energy required for the deposit and the formation time of the deposit in relation to the desired thickness of the dielectric material and its desired physical properties.

29. The method according to claim 28, in which the third gas is ammonia.

30. The method according to claim 19, in which for the purpose of obtaining a dielectric material in SiN, the first gas is silane, said chemical element of the second gas is nitrogen and the third gas is ammonia.

31. The method according to claim 19, in which the formation of the dielectric material is made under a temperature of between 100 and 600°C.

32. A method for depositing a dielectric material on copper apparent on the surface of a structure, entailing the following steps:

placing the structure in a deposit chamber of CVD type (Chemical Vapour Deposition),

adding to the chamber a gas forming a precursor for the formation of the dielectric material and containing a first element able to contaminate copper and a second element able to combine with the first element to give the dielectric material,

making the deposit of dielectric material by combining the first element and the second element,

the method also comprising a step for adding an additional gas able to prevent the contamination of the copper by said element contained in the precursor gas.

33. The method according to claim 32, in which the deposit chamber permitting plasma assisted Chemical Vapour Deposition (PECVD), the method comprises a plasma lighting stage to make the deposit of dielectric material from the precursor gas.

34. The method according to claim 32, in which in order to obtain a dielectric material in SiC said gas forming a precursor is trimethylsilane.

35. Application of the method according to claim 19 to the depositing of a copper diffusion barrier layer on the surface of a structure containing at least one conductor line in copper.

36. Application of the method according to claim 19 for the depositing of copper-diffusion barrier layers at the time of fabricating interconnection levels in copper on semiconductor devices.--

REMARKS

Claims 19-36 are active in the present application. Support for Claims 19-36 is found in Claims 1-18. No new matter is added by these amendments. An action on the merits and allowance of the claims is solicited.

Respectfully submitted,

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METHOD FOR DEPOSITING A SILICON-CONTAINING DIELECTRIC MATERIAL ON COPPER

Technical field

The present invention relates to a method for depositing a silicon-containing dielectric material on copper. It particularly concerns a method for depositing a copper-diffusion barrier layer, containing silicon, on copper conductor lines. This method is especially suitable for producing copper interconnection layers on semiconductor devices.

Prior art

In production techniques for microelectronic devices, copper is increasingly used in the fabrication of interconnections due to its electric properties and in particular to its very low resistivity. By replacing aluminium it can improve the performances of integrated circuits of microprocessor type.

For devices fabricated from a silicon substrate, the insulating materials used between the interconnection lines and between the interconnection levels contain silicon. These are SiO_2, SiN and SiON in particular.

The essential difficulty connected with the use of copper in such devices lies in the fact that a contamination by the copper of the active parts of the substrate (transistors for example) at very low levels (in the order of a few 10^{11} atoms/cm^3) is sufficient to fully degrade the performances of the corresponding circuits. Any diffusion of the copper towards the active parts must therefore be avoided. For this purpose, diffusion barrier layers in dielectric

material are known to be deposited between the copper and the active parts. Some barrier layers are deposited directly on the copper. The adhesion of the barrier layer material to the copper must also be of good quality to enable the fabrication of interconnections at several levels. The best dielectric materials for producing a copper-diffusion barrier layer are compounds containing silicon and nitrogen, of SIN_x type.

Materials of SiNx type may be deposited at relatively low temperature by methods of CVD type (Chemical Vapour Deposition) using gas mixtures in variable proportions of silane, nitrogen and ammonia. The rate of deposit is accelerated by using a plasma to decompose the reactive species.

The copper may then in turn be contaminated by the material of the barrier layer on account of the method of deposit used. The result is a very marked change in the resistivity of the copper lines. This increase in resistivity is greater the higher the temperature at which the depositing operation is conducted. This is the case in particular for inter-level deposits on copper.

The increase in copper resistivity can be accounted for by the rapid diffusion of silicon from the material of the barrier layer into the copper. A contamination formed of only 1 % silicon in solution in the copper leads to a twofold increase in the copper's resistivity, which is considerable.

Other layers of dielectric material may be deposited on the copper using precursors containing chemical elements able to contaminate copper. In addition to silicon, fluorine and carbon may be cited.

To deposit a dielectric containing silicon, silane, dimethylsilane or trimethylsilane may be used. Possible contamination of the copper by fluorine may be made by using a CF_x/CH_x mixture as precursor.

When silicon nitride is deposited on copper, the formation of a silicide on the copper has been found and used to improve the adhesion of the nitride layer to the copper. Patent US-A-5 447 887, which uses this effect, only mentions the deterioration of the surface resistivity of the copper layer: the formation of copper silicide leads to a copper consumption of less than 10% of the initial layer. However, the effect on the resistivity through the silicon being placed in solution in the remainder of the copper layer is not approached. Moreover, this method for improving the adhesion of the nitride to the copper requires the consumption of part of the initial copper layer, which limits its application to layers of relatively substantial thickness (at least 1 µm).

Patent US-A-5 831 283 teaches that the adhesion of the SiN dielectric to copper may be obtained by depositing dense SiN at low temperature and without ammonia. The formation of a silicide is not mentioned as vector of adhesion. However, the rate of the nitride deposit is too slow (26 nm/min at 200°C) which penalises productivity. This patent does not refer to any possible degradation of the resistivity of the copper underlying the nitride layer.

Description of the invention

To remedy the disadvantages listed above, the present invention puts forward a method for depositing dielectric material on copper, this method making it

possible to prevent the contamination of the copper by a contaminating element derived from a gas used to make this deposit of dielectric material, and with which it is also possible to obtain a good quality interface between the copper and the deposited dielectric material.

The subject of the invention is therefore a method for depositing a dielectric material on copper apparent on the surface of a structure, which entails the following steps:

placing the structure in a depositing chamber of CVD type (chemical vapour deposition),

adding to the chamber a first gas forming a precursor for the formation of the dielectric material and containing an element able to contaminate copper,

adding to the chamber a second gas containing a chemical element intended, together with the element contained in the first gas and able to contaminate copper, to form said dielectric material, the second gas being able to react with the first gas to give the deposit of dielectric material,

making the deposit of dielectric material from the first gas and the second gas,

characterized in that the method comprises a step for adding a third gas able to prevent contamination of the copper by said element contained in the first gas.

Advantageously, the deposit chamber permitting plasma assisted chemical vapour deposition (PECVD), the method comprises a plasma lighting step to conduct the deposit of dielectric material from the first gas and the second gas.

The first gas may be silane. The second gas may contain a chemical element which is nitrogen or it may

itself be nitrogen. The third gas may contain oxygen and/or nitrogen and/or carbon. It may be chosen from the group made up of N_xO_y, C_xH_y, a xN_2+yH_2 mixture or a xO_2+yN_2 mixture. By way of example, it may be formed of NH_3, N_20, CH_4 and C_2H_6.

According to one variant of embodiment, the first, second and third gases are also added before lighting of the plasma, the flow rates of the first, second and third gases, the energy needed for deposit and the time of formation of the deposit being adjusted in relation to the thickness of the desired dielectric material and its desired physical properties (optical, density, stress, dielectric constant).

According to another variant of embodiment, the steps are conducted in the following order:

placing the structure in the deposit chamber,

adding the third gas to the deposit chamber, the third gas being chosen to reduce the oxides present on the copper surface,

lighting a third gas plasma in the deposit chamber in order to reduce said oxides,

adding the first and second gases to the deposit chamber, adjusting the flow rates of the first, second and third gases, the energy needed for the deposit, and the time of formation of the deposit in relation to the thickness of the desired dielectric material and its desired physical properties.

The third gas may advantageously be ammonia.

To obtain a dielectric material in SiN, the first gas may be silane, the chemical element of the second gas may be nitrogen and the third gas may be ammonia.

The formation of the dielectric material may be made under a temperature of between 100 and 600°C, preferably under a temperature in the region of 400°C.

Optionally, the third gas may be the same as the second gas. It may also be a mixture. For example, it may be diluted in a neutral gas such as nitrogen, argon or helium.

A further subject of the invention is the application of this method to the depositing of a copper-diffusion barrier layer on the surface of a structure comprising at least one conductor line in copper.

Yet a further subject of the invention is the application of this method to the depositing of barrier layers against the diffusion of copper at the time of fabricating interconnection levels in copper on semiconductor devices.

Short description of the drawings

The invention will be better understood and other advantages and particular features will become apparent on reading the following description that is given by way of example and is non-restrictive, accompanied by the appended drawings among which:

figure 1 illustrates the copper plating deposition step in the fabrication of an interconnection level of damascene type,

figure 2 illustrates the mechanical-chemical polishing step in the fabrication of the interconnection level of damascene type,

figure 3 shows the interconnection level after the depositing of different layers of dielectric material.

Detailed description of embodiments of the invention

Figure 1 shows part of a substrate in silicon 1 comprising an electric contact 2 to be connected to an electric line in copper. The electric contact 2 is laterally surrounded by a dielectric material 6, in SiO_2 for example. In known manner, a layer of dielectric material 3, in SiO_2 for example, is deposited on the free surface of the structure. Layer 3 is etched such as to expose part of contact 2. A layer 4 in TiN is deposited on the etched layer 3. Layer 4 prevents the diffusion of copper into the dielectric and into the substrate in silicon 1. Plating 5 in copper is then uniformly deposited on layer 4. This plating ensures the electric connection with contact 2 and extends to above the layer of dielectric material 3.

Figure 2 shows the structure 10 obtained after the mechanical-chemical polishing stage which is continued until the layer of dielectric material 3 is reached and the layer of TiN above layer 3 is removed. After the polishing step, the polished surface of structure 10 is cleaned. It shows an apparent copper mass 15.

Figure 3 shows the interconnection level that is subsequently made. It is an interconnection level of double damascene type. It comprises a layer 11 of SiN deposited on the surface of structure 10, a layer 12 of SiO_2 covering layer 11, a layer 13 of SiN covering layer 12 and a layer 14 of SiO_2 covering layer 13. Layers 11 to 14 may be deposited at a temperature of 400°C.

Layer 11 in SiN, according to the depositing method disclosed in document US 5 831 283, was deposited in the following manner. Gases N_2 and SiH_4 are

mixed for 10 seconds in a PECVD depositing chamber. A first deposit is made at 500 W with this mixture. A second deposit is then made at 625 W at the start of which the gas NH_3 is added. This method of the prior art induces an increase of 40 % in the surface resistance of the copper over a thickness of 200 nm.

According to the invention, the increase in the surface resistance of the copper is prevented by adding the NH_3 gas before adding the SiH_4 and N_2 gases in the described example and before lighting the deposit plasma. The nitrogen enables homogenisation of the temperature and the gas phase. The first deposit of the method according to document US 5 831 283 is eliminated.

It was found that with the method of the invention, a good quality SiN/Cu interface is obtained: the nitride shows no abnormal roughness and no delamination. The properties of the SiN layer are identical to those of the method according to the prior art. Above all, no increase in the surface resistance of the copper is observed, that is to say that if there is an increase in resistance, it is less than 1 %.

A variant of embodiment of the method will be described below. With this variant it is possible to ensure good reproducibility of the Cu/SiN interface by means of a treatment with NH_3 plasma on the copper surface. This treatment leads to reducing the oxides formed on the surface of the copper.

In this case, in order to prevent reaction of the silane on the copper surface activated by the plasma of NH_3, and in order to prevent contamination of the copper by the silicon, the SiN deposit must be made as a continuation of the NH_3 plasma treatment. Once the

plasma has been lighted with the NH_3 gas and the deoxidation treatment completed, the silane and nitrogen gases are added and the ammonia flow rate is modified to obtain the necessary proportions of gases for the depositing of silicon nitride. The NH_3 plasma is made at the same temperature as the nitride deposit. The power of the NH_3 plasma may be different to that of the nitride deposit. It only needs to be adjusted without the plasma being interrupted.

A further subject of the invention is a method for depositing a dielectric material on copper apparent on the surface of a structure, entailing the following steps:

placing the structure in a deposit chamber of CVD type (chemical vapour deposition),

adding to the chamber a gas forming a precursor for the formation of the dielectric material and containing a first element able to contaminate copper and a second element able to combine with the first element to give the dielectric material,

performing the deposit of dielectric material by combining the first element and the second element,

characterized in that the method comprises a step for adding an additional gas able to prevent the contamination of the copper by said element contained in the precursor gas.

To obtain a dielectric material in SiC, the gas forming a precursor may be trimethylsilane.

CLAIMS

1. Method for depositing a dielectric material (1) on copper (15) apparent on the surface of a structure (10), entailing the following steps:

placing the structure (10) in a deposit chamber of CVD type (Chemical Vapour Deposition),

adding to the chamber a first gas forming a precursor for the formation of the dielectric material and containing an element able to contaminate copper,

adding to the chamber a second gas containing a chemical element intended, together with the element contained in the first gas and able to contaminate copper, to form said dielectric material (11), the second gas being able to react with the first gas to give the deposit of dielectric material (11),

performing the deposit of dielectric material from the first gas and the second gas,

characterized in that the method comprises a step for adding a third gas able to prevent the contamination of copper by said element contained in the first gas.

2. Method according to claim 1, characterized in that the deposit chamber enabling plasma assisted Chemical Vapour Deposition (PECVD), the method comprises a step for lighting the plasma to conduct the deposit of dielectric material from the first gas and the second gas.

3. Method according to either of claims 1 to 2, characterized in that the first gas is silane, the contaminating element being Si.

4. Method according to either of claims 1 or 2, characterized in that said chemical element of the second gas is nitrogen.

5. Method according to either of claims 1 or 2, characterized in that the second gas is nitrogen.

6. Method according to either of claims 1 or 2, characterized in that the third gas contains oxygen and/or nitrogen and/or carbon.

7. Method according to claim 6, characterized in that the third gas is chosen from the group made up of N_xO_y, C_xH_y, a xN_2+yH_2 mixture or a xO_2+yN_2 mixture.

8. Method according to claim 6, characterized in that the third gas is chosen from the group made up of NH_3, N_2O, CH_4 and C_2H_6.

9. Method according to either of claims 1 or 2, characterized in that the first, second and third gases are also added before lighting of the plasma, the flow rates of the first, second and third gases, the energy required for depositing and the time of formation of the deposit being adjusted in relation to the desired thickness of the dielectric material (11) and its desired physical properties.

10. Method according to claim 2, characterized in that the steps are conducted in the following order:

placing the structure (10) in the deposit chamber,

adding the third gas to the deposit chamber, the third gas being chosen to reduce the oxides present on the surface of the copper (15),

lighting a plasma of third gas in the deposit chamber in order to reduce said oxides,

adding the first and second gases to the deposit chamber, adjusting the flow rates of the first, second and third gases, the energy required for the deposit and the formation time of the deposit in relation to the desired thickness of the dielectric material (11) and its desired physical properties.

11. Method according to claim 10, characterized in that the third gas is ammonia.

12. Method according to either of claims 1 or 2, characterized in that, for the purpose of obtaining a dielectric material in SiN, the first gas is silane, said chemical element of the second gas is nitrogen and the third gas is ammonia.

13. Method according to any of claims 1 to 12, characterized in that the formation of the dielectric material (11) is made under a temperature of between 100 and 600°C.

14. Method for depositing a dielectric material (11) on copper (15) apparent on the surface of a structure (10), entailing the following steps:

placing the structure (10) in a deposit chamber of CVD type (Chemical Vapour Deposition),

adding to the chamber a gas forming a precursor for the formation of the dielectric material (11) and

containing a first element able to contaminate copper and a second element able to combine with the first element to give the dielectric material (11),

performing the deposit of dielectric material by combining the first element and the second element,

characterized in that the method comprises a step for adding an additional gas able to prevent the contamination of the copper by said element contained in the precursor gas.

15. Method according to claim 14, characterized in that the deposit chamber permitting plasma assisted Chemical Vapour Deposition (PECVD), the method comprises a plasma lighting stage to make the deposit of dielectric material from the precursor gas.

16. Method according to either of claims 14 or 15, characterized in that, in order to obtain a dielectric material in SiC, said gas forming a precursor is trimethylsilane.

17. Application of the method according to any of the preceding claims to the depositing of a copper-diffusion barrier layer on the surface of a structure (10) containing at least one conductor line in copper (15).

18. Application of the method according to any of claims 1 to 16 for the depositing of copper-diffusion barrier layers at the time of fabricating interconnection levels in copper on semiconductor devices.

ABSTRACT OF THE DISCLOSURE

METHOD FOR DEPOSITING A SILICON-CONTAINING DIELECTRIC MATERIAL ON COPPER

The invention concerns a method for depositing a dielectric material (11) on copper (15) apparent on the surface of a structure (10), entailing the following steps:

placing the structure (10) in a depositing chamber of CVD type (Chemical Vapour Deposition),

adding to the chamber a first gas forming a precursor for the formation of the dielectric material and containing an element able to contaminate copper,

adding to the chamber a second gas containing a chemical element intended, together with the element contained in the first gas and able to contaminate copper, to form said dielectric material (11), the second gas being able to react with the first gas to give the deposit of dielectric material (11),

performing the deposit of dielectric material from the first gas and the second gas,

characterized in that the method comprises a step for adding a third gas able to prevent the contamination of copper by said element contained in the first gas.

Fig. 3

FIG. 1

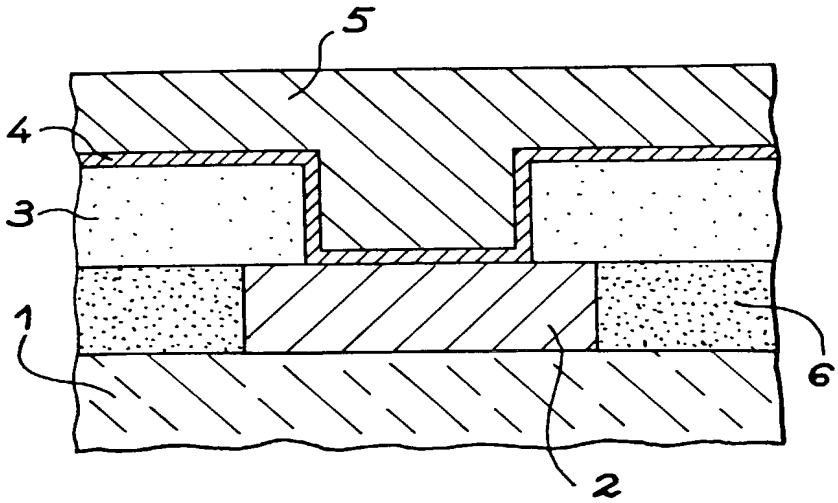


FIG. 2

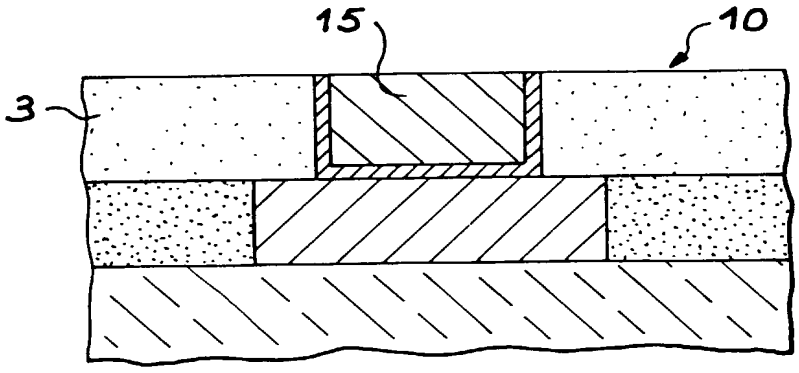
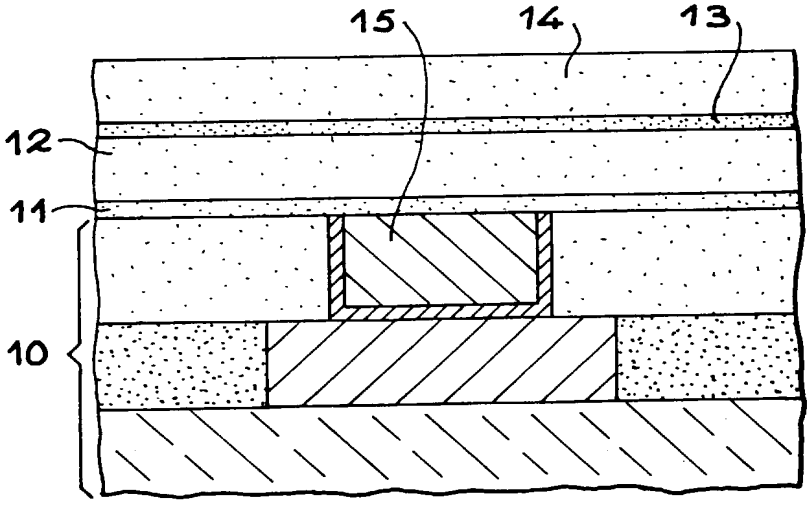


FIG. 3



B 13306.3 JL

Declaration, Power Of Attorney and Petition

WE (I) the undersigned inventor(s), hereby declare(s) that :

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first, and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled
METHOD FOR DEPOSITING A SILICON-CONTAINING DIELECTRIC MATERIAL ON COPPER

the specification of which

☐ is attached hereto.

☐ was filed on

as Application Serial No.

and amended on

☒ was filed as PCT international application

Number PCT/FR00/01891

on July 03, 2000

and was amended under PCT Article 19

on

We (I) hereby state that we (I) have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations.

We (I) hereby claim foreign priority benefits under 35 U.S.C. § 119 (a)-(d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365 (a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application (s)

Application No.	Country	Day/month/Year	Priority Claimed
99 08474	FRANCE	01 JULY 1999	☒ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

We (I) hereby claim the benefit under Title 35, United States Code, § 119 (e) of any United States provisional application(s) listed below.

(Application Number) (Filing Date)

(Application Number) (Filing Date)

We (I) hereby claim the benefit under 35 U.S.C. §120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of prior application and the national or PCT International filing date of this application.

Application Serial No.	Filing Date	Status (pending, patented, abandoned)

And we (I) hereby appoint : Norman F. Oblon, Registration Number ~~24,618;~~ Marvin J. Spivak, Registration Number 24,913; C, Irvin McClelland, Registration Number 21,124; Gregory J. Maier, Registration Number ~~25,599;~~ Arthur I. Neustadt, Registration Number ~~24,854;~~ Richard D. Kelly, Registration Number ~~27,757~~; James D. Hamilton, Registration Number ~~28,421~~; Eckhard H. Kuesters, Registration Number ~~28,870;~~ Robert T. Pous, Registration Number ~~29,099;~~ Charles L. Gholz, Registration Number ~~26,395;~~ William E. Beaumont, Registration Number ~~30,996~~; Jean-Paul Lavalleye, Registration Number ~~31,451~~; Stephen G. Baxter, Registration Number ~~32,884;~~ Richard L. Treanor, Registration Number ~~36,379;~~ Steven P. Weihrouch, Registration Number ~~32,829;~~ John T. Goolkasian, Registration Number ~~26,142;~~ Richard L. Chinn, Registration Number ~~34,305~~; Steven E. Lipman, Registration Number ~~30,011;~~ Carl E. Schlier, Registration Number 34,426; James J. Kulbaski, Registration Number ~~34,648~~; Richard A. Neifeld, Registration Number 35,299; J. Derek Mason, Registration Number ~~35,270~~; Surinder Sachar, Registration Number ~~34,423;~~ Christina M. Gadiano, Registration Number 37,628; Jeffrey B. McIntyre, Registration Number 36,867; William T. Enos, Registration Number ~~33,128;~~ Michael E. McKabe Jr., Registration Number ~~37,182;~~ Bradley D. Lytle, Registration Number ~~40,073~~ and Michael R. Casey Registration Number ~~40,294~~; our (my) attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith; and we (I) hereby request that all correspondence regarding this application be sent to the firm of ~~OBLON, SPIVAK, McCLELLAND, MAIER~~ & NEUSTADT, P.C., whose post Office Address is : Fourth Floor, 1755 Jefferson Davis Highway, Arlington, Virginia ~~22202.~~

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true ; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardise the validity of the application or any patent issuing thereon.

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